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Indian Standard

GUIDELINES FOR ADDITION OF ESSENTIAL NUTRIENTS TO FOOD

UDC 664·099·62 (026)

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

March 1992

Price Group 4

Nutrition Sectional Committee, FAD 21

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Nutrition Sectional Committee had been approved by the Food and Agriculture Division Council.

These guidelines would be useful to manufacturers of various food items in understanding the importance of various nutrients in health and their uses so that they may maintain or improve the overall nutritional quality of foods and prevent the indiscriminate addition of these nutrients thereby decreasing the risk of health hazards due to essential nutrient excesses, deficits or imbalances. It would also help the manufacturer to know about the various nutrients lost during processing thereby enabling these to be added after processing. These would also be useful to consumer as it would help him to understand the principles of nutrition so that he is not misled or deceived.

The basic purpose of these guidelines is to give essential basic information and for further detailed information, including the Recommended Dietary Allowances, reference may be made to the Nutritive Value of Indian Food, published by ICMR. Table 1 of this Indian Standard has been reproduced from the latest edition of the above publication.

Indian Standard

GUIDELINES FOR ADDITION OF ESSENTIAL NUTRIENTS TO FOOD

1 SCOPE

This standard gives the general information on essential nutrients and the basic principles for addition of these to food.

2 DEFINITIONS

2.1 Nutrient means any substance normally consumed as a constituent of food:

a) which provides energy; or

b) which is needed for growth, development and maintenance of healthy state of life; or

c) a deficit of which will cause characteristic bio-chemical or physiological changes in health.

2.2 Essential nutrient means any substance normally consumed as a constituent of food which is needed for growth, development and maintenance and which cannot be synthesized in adequate amounts by the body.

2.3 Nutritional equivalent means being of similar nutritive value in terms of quantity and quality of protein and bioavailability of essential nutrients. For this purpose, nutritional equivalence means that the essential nutrients provided by the food being substituted, that are present in a servings or portion or 100 kcal of the food at a level of 5% or more of the recommended intake of the nutrient(s) are present in the substituted or partially substituted food (extender) in comparable amounts.

2.4 Substitute food is a food which is designed to resemble a common food in appearance, texture, flavour and odour, and is intended to be used as a complete or partial replacement of the food it resembles.

2.5 Fortification or enrichment means the addition of one or more essential nutrients to a food over and above the levels normally contained in the food or the levels after restoration for the purpose of preventing or correcting a demonstrated deficiency of one or more nutrients in the population or specific population groups.

2.6 Restoration means the addition of nutrient(s) to a food which are lost during the course of good manufacturing practice, or during normal storage and handling procedures, in amounts which will be present in the edible portion of the food before processing, storage of handling.

2.7 Special purpose foods are foods that have been designed to perform a specific function, such as to replace a meal which necessitates a content of essential nutrients which cannot be achieved except by addition of one or more of these nutrients. These foods include but are not limited to foods for special dietary use.

3 BASIC INFORMATION ON ESSENTIAL NUTRIENTS

The important nutrients, their uses, sources rich in these and the daily requirements in general are given. The recommended dietary intake of nutrients of different age group as well as in different physiological conditions as recommended by the Nutrition Expert Group of ICMR in 1989 are given in Table 1.

3.1 Proteins

These are macronutrients present in foods and are used by the body for building tissues, complex enzymes, antibodies, etc. One gram of protein provides 4 calories. However, the use of protein for energy purpose is costly and wasteful. This can be prevented by adequate intake of energy through other sources. Chemically, proteins consist of amino acids, joined in polypeptide chains. Some of these amino acids cannot be synthesized in the body and are considered as 'essential' (*see* Table 2). The important function of dietary proteins is to satisfy the quantitative needs of nitrogen as well as essential amino acids. The quality of a protein is its ability to meet the dietary requirements of nitrogen and essential amino acids. Thus the essential amino acid composition of a protein and its digestibility and hence availability of amino acids are the two important factors which determine the quality of a protein. Protein of whole egg of hen and human milk are the best quality protein. The proteins of animal origin in general are superior in quality as compared to vegetable proteins, which are deficient in certain essential amino acids. However, the quality of these can be improved through a proper combination of foods (e.g. cereals and pulses), as deficiency of a particular amino acid in one food may be made up by its excess in another food to ultimately provide a balanced proportion of required amino acids.

Rich sources of protein include meat, fish, eggs, milk, oilseeds, pulses and nuts.

The daily protein requirements of an adult is about 1 g per kg of body weight. For growing children, pregnant and nursing women, the requirement of proteins is higher (*see* Table 1).

Table 1 Recommended Dietary Allowances for Indians

(*Clause* 3)

Group	Particulars	Body Weight	Net Energy	Protein	Fat	Calcium	Iron1)	Vit. A. μg/d		Thiamin	Riboflavin	Nicotinic Acid	Pyridoxin	Ascorbic Acid	Folic Acid	Vit. B-12
								Retinol	β-carotene							
		kg	Kcal/d	g/d	g/d	mg/d	mg/d			mg/d	mg/d	mg/d	mg/d	mg/d	μg/d	μg/d
Man	Sedentary work	60	2 425	60	20	400	28	600	2 400	1·2	1·4	16	2·0	40	100	1
	Moderate work		2 875							1·4	1·6	18				
	Heavy work		3 800							1·6	1·9	21				
Woman	Sedentary work	50	1 875	50	20	400	30	600	2 400	0·9	1·1	12	2·0	40	100	1
	Moderate work		2 225							1·1	1·3	14				
	Heavy work		2 925							1·2	1·5	16				
	Pregnant women	50	+300	+15	30	1 000	38	600	2 400	+0·2	+0·2	+2	2·5	40	400	1
	Lactation															
	0-6 months	50	+550	+25	45	1 000	30	950	3 800	+0·3	+0·3	+4	2·5	80	150	1·5
	6-12 months		+400	+18						+0·2	+0·2	+3				
Infants	0-6 months	5·4	108/kg	2·05/kg		500				55μg/kg	65μg/kg	710μg/kg	0·1	25	25	0·2
	6-12 months	8·6	98/kg	1·65/kg				350	1 200	50μg/kg	60μg/kg	650μg/kg	0·4			
Children	1-3 years	12·2	1 240	22	25	400	12	400	1 600	0·6	0·7	8	0·9	40	30	0·2-1·0
	4-6 years	19·0	1 690	30			18	400		0·9	1·0	11			40	
	7-9 years	26·9	1 950	41			26	600	2 400	1·0	1·2	13	1·6		60	
Boys	10-12 years	35·4	2 190	54	22	600	34	600	2 400	1·1	1·3	15	1·6	40	70	0·2-1·0
Girls	10-12 years	31·5	1 970	57			19			1·0	1·2	13				
Boys	13-15 years	47·8	2 450	70	22	600	41	600	2 400	1·2	1·5	16	2·0	40	100	0·2-1·0
Girls	13-15 years	46·7	2 060	65			28			1·0	1·2	14				
Boys	16-18 years	57·1	2 640	78	22	500	50	600	2 400	1·3	1·6	17	2·0	40	100	0·2-1·0
Girls	16-18 years	49·9	2 060	63			30			1·0	1·2	14				

1) On a mixed serial diet with absorption of 3% in man, 5% in woman, and 8% in pregnant woman.

Table 2 Essential Amino Acids

(*Clause* 3.1)

Phenylalinine
Valine
Tryptophan
Threonine
Isoleucine
Methionine
Lysine
Leucine

NOTE — In addition, Histidine and Cystine, Tyrosine are also essential for infants.

3.2 Fats

Fats are glycerol esters of a number of fatty acids, saturated and unsaturated. These, in addition to serving as a concentrated source of energy (1 g provides 9 Calories), also help in absorption of fat soluble vitamins and provide essential fatty acids which are required by the body for growth and maintenance and integrity of skin. Excess of fats, particularly saturated fat, in the diet leads to increased blood cholesterol which in turn is associated with coronary heart diseases. High fat intake also leads to obesity.

15-25 grams of visible fats are required to meet the essential fatty acid requirements. However, it is desirable that the fat should contribute not more than 15 to 20 percent calories in the diet. Some of this is available as invisible fat from cereal and pulses, milk and its products, nuts, oilseeds etc. A total of 20 to 30 gram of fat can be safely consumed daily which should include at least 10 gram of vegetable oils to supply the necessary amount of essential fatty acids.

Fats like butter, ghee, coconut oil, hydrogenated vegetable oil (vanaspati), are richer in saturated fatty acids which gives them a solid appearance. On the other hand vegetable oils such as groundnut, mustard, seasame, soya, sunflower, safflower, etc, contain large amounts of unsaturated fatty acids of higher molecular weight which gives them an oily texture due to the presence of fatty acids like linoleic, linolenic etc. Fatty acids play an important role in several metabolic processes. Unsaturated fatty acids get converted to saturated ones during metabolic processes and hydrogenation. Unsaturated fatty acids are helpful in lowering the blood cholesterol levels found in cases of coronary heart diseases. Unsaturated fats also do not raise the level of blood cholesterol.

3.3 Carbohydrates

Carbohydrates are made up of the elements carbon, hydrogen and oxygen with hydrogen and oxygen present in the same proportion as that in water, namely, 2 : 1. Carbohydrates include sugar, starches and cellulose. Carbohydrates have to be broken down into simple sugars before they can be absorbed and used by the body.

Carbohydrates form the bulk of the diet. Their primary function is to supply energy for various body processes and at the same time are cheaper amongst food constituents. Commonly consumed carbohydrates are cane sugar (sucrose), glucose, lactose, maltose, starch, dextrins, etc. Celluloses and hemi-celluloses are not digestible and are voided as such but are very important as they provide the fibre or roughage to the diet (*see also* **3.4**).

3.3.1 *Available Carbohydrates*

This term represents the portion of the carbohydrate of food which is available to the human body for energy and glycogen formation. It includes starch, dextrins, glycogen, maltose sucrose, lactose, glucose, fructose, galactose, mannose and pentoses.

3.4 Dietary Fibre

Dietary fibre consists of indigestible organic tissues of plant origin and is necessary to aid the mechanics of digestion and elimination of wastes thereby counteracting the tendency to constipation. Lack of fibre in the diet is considered to be an important contributory factor leading to colonic cancer. Current research indicates that adequate levels of dietary fibre help in lowering blood sugar as well as cholesterol level.

3.5 Energy Value

The energy valve or calorific value of a food depends upon the relative amount of the three energy nutrients, namely, carbohydrates, fats and proteins. This is determined either by complete combustion in a colorimeter experimentally or by calculation from its contents of the primary energy nutrients on the basis that 1 g of protein, carbohydrate and fat yield 4, 4 and 9 calories respectively. The term calorie or joule can also be used as an alternative for the term energy.

The energy requirements of a person comprises of two components : (a) the basal energy required for such functions as respiration, circulation, etc; and (b) the energy required for the actual physical activity of the individual. The calories requirements are dependent on the work and activity, age, sex, physiological condition or state, etc. The requirement for each age group is given in Table 1.

In a balanced diet 10 to 15 percent calories should be derived from protein, 15 to 20 percent from fat and the rest from carbohydrates. To plan these diets, the requirement of protein, fat, vitamins and minerals should be first considered and carbohydrate rich foods can then be included in sufficient amounts to meet the energy needs.

3.6 Vitamins

Vitamins are nutrients needed in very small quantities for the proper functioning of the body. These are generally classified into fat-soluble and water-soluble vitamins.

3.6.1 *Fat-Soluble Vitamins*

These include vitamins A, D, E and K and are generally stored in the lipid deposits of the body particularly in the liver. Because of their lack of solubility in water, the daily requirements of these are less stringent than for the water-soluble vitamins as these stores can last up to several months. However, if taken in large amounts, these can lead to hypervitaminosis (vitamin toxicity) as the removal of overload is also very slow.

3.6.1.1 *Vitamin A*

Vitamin A also known as retinol is essential for normal vision, for maintaining integrity of epethelial cells and a variety of metabolic functions. Deficiency of this vitamin leads to disorders of vision and in severe cases results in permanent blindness. Excess intake is also known to have toxic effects. Light, particularly ultra-violet light, air and rancid fats have a destructive influence on vitamin A.

The liver is the richest source of vitamin A as excess of it is stored in the liver of animals. Other sources of this vitamin include butter, fish liver oils, ghee, whole milk, curds, egg yolk, etc. This vitamin is not present as such in vegetable foods but these foods contain substances known as carotenes or pro-vitamin A which are converted into Vitamin A in the body. Important sources of carotenes are leafy vegetables and red or orange coloured fruits and vegetables.

Vitamin A is measured in terms of international units (IU) or micrograms (μg) (1 IU is equivalent to 0·3 μg of vitamin A). The daily requirement of an adult is about 750 μg or 2500 IU.

3.6.1.2 *Vitamin D*

This is chemically known as Calciferol and is important in calcium absorption and for bone formation. Lack of this vitamin leads to rickets in children or osteomalacia in adults. Vitamin D is formed in the skin by the action of sunlight which transforms a substance normally present in the skin, namely, 7-Dehydrochole-calciferol into the vitamin. Fish liver oil is a rich source of vitamin D, the vitamin is also present in egg yolk and milk fat obtained from animals fed on green pastures exposed to sunlight, etc.

Vitamin D is measured in terms of IU or μg (1 IU is equivalent to 0·25 μg of vitamin D).

The daily requirement of children is about 200 to 400 IU (5-10 μg). Requirement for adult are lesser. Most of the requirement of vitamin D is met by the action of sunlight on skin. However, it may not be advisable to rely entirely on sunshine for obtaining vitamin D requirement especially in the case of children. Excessive intake of this vitamin can lead to toxic symptoms.

3.6.1.3 *Vitamin E*

This is chemically called α-tocopherol. It possesses anti-oxidant properties. However, the amount of this vitamin required by human has not been established. It is present in the germs of cereals and in raw vegetable oils. Vitamin E is sensitive to oxidation and ultra-violet light.

3.6.1.4 *Vitamin K*

This vitamin is necessary for proper blood clotting. It possesses a Naptho-quinone structure. The natural form includes Vitamin K_1, occurring in green leaves and vitamin K_2 produced by intestinal bacteria.

3.6.2 *Water-Soluble Vitamins*

These comprise of all vitamins of the B-group, namely, Thiamine, Riboflavin, Niacin, Pyridoxine, Pantothenic acid, folic acid, biotin, Cyanocobalamin and Vitamin C. These being water soluble are not stored in the body and excess amounts are excreted in the urine. Hence, these must be replenished frequently.

3.6.2.1 *Thiamine* (*Vitamin B_1*)

Lack of thiamine in the diet leads to loss of appetite, muscular weakness and neurological changes. Acute deficiency results in a condition known as beri-beri. Physiologically, the vitamin is concerned with proper utilization of carbohydrates in the body and in the absence of adequate amounts of thiamine, efficient utilization of sugars and starches for energy needs, is adversely affected. Thiamine requirement therefore increases when the proportion of carbohydrates in the diet is high.

Rich sources of thiamine include whole cereal, pulses, oilseeds, meat and liver. The requirement of this vitamin is expressed in terms of calorie intake and is about 0.5 mg of vitamin per 1 000 calories.

3.6.2.2 *Riboflavin* (*Vitamin B_2*)

This is essential for proper cell function. Deficiency of this vitamin leads to roughness of tongue (glossitis) and mouth corners (angular stomatitis). Physiologically it is concerned with several oxidation processes inside the cell.

Good sources of vitamin include milk and milk products, egg, liver and green leafy vegetables.

Human requirements are related to energy expenditure and, therefore, to calories intake. The requirement of this vitamin is about 0·5 mg per 1 000 calories.

3.6.2.3 *Niacin*

This vitamin is also known as nicotinic acid and is essential for proper cell functioning. Deficiency of this vitamin causes a condition known as Pellagra characterized by pigmented scaly skin, soreness of the tongue and diarrhoea. The amino acid, tryptophan found in foods is converted to nicotinic acid in the body. This aspect has to be taken into account while calculating niacin requirement.

Rich sources of niacin include groundnut, pulses, whole wheat and unmilled rice. Milk although poor in niacin is rich in tryptophan.

The requirement of Niacin is also related to calories consumption and is about 6·6 mg per 1 000 calories.

3.6.2.4 *Folic acid*

This vitamin also known as folacin is involved in the multiplication and maturation of cells and deficiency results in certain types of anemias especially in infants and pregnant women.

Good sources of vitamin include fresh green vegetables, liver and pulses.

Requirement is about 100 µg per day.

3.6.2.5 *Vitamin B_{12} (Cyanocobalamin)*

This vitamin is also involved in the maturation of cells and deficiency results in certain types of anemias, as in the case of folic acid.

Only animal foods like milk, meat, liver contain vitamin B_{12}. The requirement is about 1 µg per day.

3.6.2.6 *Vitamin C*

This water-soluble vitamin is chemically known as ascorbic acid. Deficiency causes a condition known as scurvy. Vitamin C strengthens the bones and teeth and protects against infection. It helps in the absorption of iron from the intestines. This vitamin is easily oxidized by air especially in the presence of heat, light and metals. One of its characteristic properties is its intense reducing action and hence the tendency to get rapidly oxidized in air. Heating or drying of fruits, therefore, leads to destruction of all or most of the vitamin present in them.

Rich sources of vitamin C include guava, amla, papaya, citrus fruits, tomatoes, sprouted whole pulses and green leafy vegetables.

Daily requirement of the vitamin for both adults and children is about 30 to 50 mg per day.

3.7 Mineral

Mineras constitute a small portion of the body tissue (about 4 percent) but are essential as structural components and play a vital role in many metabolic processes. Minerals important from the nutritional aspect include calcium, iron, sodium, magnesium, phosphorous, potassium, iodine, zinc, etc. Some of the minerals are lost during the refining process.

3.7.1 *Calcium*

This mineral is required for building strong bones and teeth, for contraction of heart and skeletal muscles, clotting of blood, etc.

Rich sources include milk, green leafy vegetables, tapioca and ragi.

Adults require about 0·4 to 0·6 g calcium per day. Children need relatively more calcium to meet the needs of growing bones. Pregnant and nursing women also require higher amounts.

3.7.2 *Phosphorus*

The utilization of phosphorus in the body is closely related to that of calcium as most of the calcium is deposited in the bones and teeth as calcium phosphate. The ratio of calcium to phosphorus is an important aspect in the diet and is recommended at a level 2 : 1. Phosphorus also plays an essential role in assimilation of carbohydrates and fats and is also used to buffer formulated foods against changes in the acid-base balance.

Rich sources include milk, cereals, pulses, nuts and oilseeds.

3.7.3 *Iron*

Iron is required for synthesis of haemoglobin, an assenial constitutent of the red blood cells. Deficiency of this mineral results in anemia. The body guards its iron stores very carefully and re-uses the broken down iron. Only a small amount needs to be replaced daily which is 0·9 mg for males and 1·5 mg for females. Bioavailability of iron varies considerably depending upon dietary sources. Absorption of iron is higher in the case of liver and non-vegetarian food as compared to vegetarian sources. Absorption of iron is influenced by the presence of inorganic phosphates or oxalates which decrease absorption and presence of vitamin C which increases its absorption. Absorption is only 3 to 5 percent from a cereal-base diet due to interference from phytates. The dietary requirement is therefore kept at 20 to 30 mg per day.

Rich sources include green leafy vegetables, bajra, ragi, jaggery, egg yolk and liver.

3.7.4 *Sodium*

This is an important constituent of fluid present outside the cells and a small amount inside the cell. An appropriate concentration of this element in the body fluid is necessary to keep the cells in proper shape. It is intimately connected with transmission of nerve impulses and with skeletal and cardiac muscle contraction. Excess or lack causes mal-functioning of the heart. Common salt including iodized salt is the main source of sodium in the diet. The daily intake of sodium chloride added through salt to the diet is about 10 to 15 gram. Food from animal sources contain more sodium than food from plant sources. Due to high levels of added salt, the sodium present in food stuff has little practical significance under normal conditions.

Certain processed foods contain large amount of sodium due to the preservatives added.

3.7.5 *Potassium*

It is found primarily inside cells where it functions in association with various enzymes. As in the case of sodium, potassium is also intimately concerned with trasmission of nerve impulses and with skeletal and cardiac muscles contraction. Excess or lack of potassium causes mal-functioning of the heart.

The daily requirement is not known with certainity but the estimated amount is 2 to 4 g. The average diet readily supplies this since potassium is wide spread in vegetables, fruits and meat.

4 BASIC PRINCIPLES FOR ADDITION OF NUTRIENTS TO FOODS

4.1 Essential nutrients may be added to foods for the purpose of:

a) Restoration;

b) Upgradation of the nutritional quality of the substitute foods;

c) Fortification, to provide essential nutrients; and

d) Ensuring the appropriate nutrient composition of a special purpose food.

4.1.1 *Restoration*

Where the food has been identified as a significant source of energy and/or essential nutrients in the food supply, and particularly where there is demonstrated evidence of public health need, restoration of the essential nutrients of concern lost during processing, storage or handling should be strongly recommended.

A food should be considered a significant source of an essential nutrient if the edible portion of the food prior to processing, storage or handling contains the essential nutrient in amounts equal to or greater than 10 percent of the recommended nutrient intake in reasonable daily intake.

4.1.2 *Upgradation of the Nutritional Quality of the Substitute Foods*

Where a substitute food is intended to replace a food which has been identified as a significant source of energy and/or essential nutrients in the food supply, and particularly where there is demonstrated evidence of public health need, nutritional equivalence in terms of the essential nutrients of concern should be strongly recommended.

A food being substituted or partially substituted should be considered a significant source of an essential nutrient if a serving or portion or 100 kcal of the food contains the essential nutrient in amounts equal to or greater than 5 percent of the recommended nutrient intake.

Where there is a clear public health necessity to moderate the intake of a specific nutrient, the level of this nutrient need not be equivalent.

4.1.3. *Fortification*

Fortification should be the responsibility of national authorities since the kinds and amounts of essential nutrients to be added and foods to be fortified will depend upon the particular nutritional problems to be corrected, the characteristics of the target populations, and the food consumption patterns of the area have to be taken into consideration.

The following conditions should be fulfilled for any fortification programme:

There should be a demonstrated need for increasing the intake of an essential nutrient in one or more population groups. This may be in the form of actual clinical or subclinical evidence of deficiency, estimates indicating low levels of intake of nutrients or possible deficiencies likely to develop because of changes taking place in food habits.

The food selected as a vehicle for the essential nutrient(s) should be a part of the diet of the population at risk.

The intake of the food selected as a vehicle should be stable and uniform and the lower and upper levels of intake should be known.

The amount of the essential nutrient added to the food should be sufficient to correct or prevent the deficiency when the food is consumed in normal amounts by the population at risk.

The amount of the essential nutrient added should not result in excessive intakes by individuals with a high intake of fortified food.

4.1.4 *Ensuring the Appropriate Nutrient Composition of a Special Purpose Food*

Nutrients may be added to special purpose foods including foods for special dietary uses to ensure an appropriate and adequate nutrient content.

4.2 The essential nutrient should be present at a optimal level which will not result in either an excessive or less intake of the added essential nutrient considering amounts from other sources in the diet.

4.3 The addition of an essential nutrient to a food should not result in an adverse effect on the metabolism of any other nutrient.

4.4 The essential nutrient should be sufficiently stable in the food under customary conditions of packaging, storage, distribution and use.

4.5 The essential nutrient added should be biologically available from the food.

4.6 The essential nutrient added should not impart undesirable characteristics to the food (for example colour, taste, flavour, texture, cooking properties) and should not unduly shorten its shelf-life.

4.7 Technology and processing facilities should be available to permit the addition of the essential nutrient in a satisfactory manner.

4.8 Addition of essential nutrients to foods should not be used to mislead or deceive the consumer as to the nutritional merit of the food.

4.9 The additional cost should be compatible to the intended consumer.

4.10 Methods of measuring, controlling and/or enforcing the levels of added essential nutrients in foods should be available.

4.11 When provision is made in food standards, regulations or guidelines for the addition of essential nutrients to foods, specific provisions should be included to identify the essential nutrients to be present in the food to achieve their intended purpose.

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Indian Standards are reviewed periodically and revised, when necessary and amendments, if any, are issued from time to time. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition. Comments on this Indian Standard may be sent to BIS giving the following reference :

Doc : No. FAD 21 (4373)

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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Printed at Swatantra Bharat Press, Delhi, India